DRAFT
REMEDIAL ALTERNATIVES MEMORANDUM

FOR THE
GULFCO MARINE MAINTENANCE
SUPERFUND SITE
FREEPORT, TEXAS

PREPARED BY:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Drive, Suite 4004
Round Rock, Texas 78664
(512) 671-3434

DECEMBER 17, 2010

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LIST OF ACRONYMS

1,2,3-TCP - 1,2,3-trichloropropane
ARARs - Applicable or Relevant and Appropriate Requirements
AST – Aboveground Storage Tank
BaP - Benzo(a)pyrene
BERA – Baseline Ecological Risk Assessment
CERCLA – Comprehensive Environmental Response, Compensation and Liability Act
COI – Chemicals of Interest
COPEC – Chemicals of Potential Ecological Concern
CSM – Conceptual Site Model
DDT – dichlorodiphenyltrichloroethane
EPA – United States Environmental Protection Agency
FS – Feasibility Study
GRG - Gulfco Restoration Group
NEDR – Nature and Extent Data Report
NPL – National Priorities List
O&M - Operation and Maintenance
PAH – Polynuclear Aromatic Hydrocarbon
PBW – Pastor, Behling & Wheeler, LLC
PCB – Polychlorinated Biphenyl
PRG - Preliminary Remediation Goal
PSA - Potential Source Area
PSCR - Preliminary Site Characterization Report
RAM - Remedial Alternatives Memorandum
RAO - Remedial Action Objective
RI – Remedial Investigation
RI/FS – Remedial Investigation/Feasibility Study
SLERA – Screening-Level Ecological Risk Assessment
SOW – Statement of Work
TCEQ – Texas Commission on Environmental Quality
TCRA - Time Critical Removal Action
TDS - Total Dissolved Solids
TNRCC – Texas Natural Resource Conservation Commission
TCE - Trichloroethene
UAO – Unilateral Administrative Order
USFWS - United States Fish and Wildlife Service

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. (Gulfco) in Freeport, Brazoria County, Texas (the Site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required Respondents to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site. Pursuant to Paragraphs 17 through 28 of the Statement of Work (SOW) for the RI/FS, included as an Attachment to the UAO, a RI/FS Work Plan and a Sampling and Analysis Plan were prepared for the Site. These documents were approved with modifications by EPA on May 4, 2006 and were finalized on May 16, 2006. This Remedial Alternatives Memorandum (RAM) has been prepared in accordance with Paragraphs 44 and 45 of the SOW and Section 5.10 of the approved RI/FS Work Plan (the Work Plan) (PBW, 2006). The memorandum was prepared by Pastor, Behling & Wheeler, LLC (PBW), on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow), collectively known as the Gulfco Restoration Group (GRG). Figure 1 provides a map of the Site vicinity, while Figure 2 provides a Site map.

1.1 PURPOSE AND ORGANIZATION

As described in the SOW, the purpose of the RAM is to develop a range of remedial alternatives and screen those alternatives in relation to the Remedial Action Objectives (RAOs) and the more specific Preliminary Remediation Goals (PRGs) for the Site. Consistent with EPA guidance regarding reporting and communication during the alternative development and screening process (Section 4.5 of EPA, 1988), the RAM provides written documentation of the methods, rationale, and results of the alternative screening. As such, the RAM provides the foundation for the more detailed analysis of alternatives in the FS.

Consistent with its role as an interim deliverable for the FS, the RAM has been organized to match the suggested format for the technology and alternative screening sections of the FS as provided in EPA, 1988. Site background information is provided below in Section 1.2. The identification and screening of technologies is discussed in Section 2. The development and screening of alternatives is described in Section 3. Memorandum conclusions are provided in Section 4. References are listed in Section 5. Consistent with SOW requirements and as specified in the Work Plan, Appendix A summarizes the chemical, location, and action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for each of the alternatives.

1.2 SITE BACKGROUND

1.2.1 Site Description

The Site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The Site consists of approximately 40 acres within the 100-year coastal floodplain along the north bank of the Intracoastal Waterway between Oyster Creek approximately one mile to the east and the Texas Highway 332 bridge approximately one mile to the west. Marlin Avenue divides the Site into two primary areas (Figure 2). For the purposes of descriptions in this report, Marlin Avenue is approximated to run due west to east. The 20-acre upland property south of Marlin Avenue (the South Area) was created from dredged material from the Intracoastal Waterway and developed for industrial uses. It contains multiple structures, a dry dock, an aboveground storage tank (AST) tank farm, and two barge slips connected to the Intracoastal Waterway. The property to the north of Marlin Avenue (the North Area) contains some upland areas created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (Figure 3). The North Area contains three adjacent closed surface impoundments and two ponds, the “Fresh Water Pond” immediately east of the impoundments, and a smaller pond to the southeast (referred to as the “Small Pond” hereafter). Site investigation activities (described below) identified a localized area of buried debris immediately south of the former surface impoundments.

The South Area is zoned as “W-3, Waterfront Heavy” by the City of Freeport. This designation provides for commercial and industrial land use, primarily port, harbor, or marine-related activities. The North Area is zoned as “M-2, Heavy Manufacturing.” Restrictive covenants prohibiting any land use other than commercial/industrial and prohibiting groundwater use have been filed for all parcels within both the North and South Areas. Additional restrictions requiring any building design to preclude indoor vapor intrusion have been filed for Lots 55, 56 and 57 (see Figure 2 for lot designations and boundaries). A further restriction requiring EPA and Texas Commission on Environmental Quality (TCEQ) notification prior to any building construction has also been filed for Lots 55, 56, and 57. Copies of these restrictions for Lots 55, 56, 57 are provided in Appendix B.

Adjacent property to the north, west and east of the North Area is unused and undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intracoastal Waterway bounds the Site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the Site, and 1,000 feet east of the Site.

1.2.2 Site History

The Site's operating history, as constructed through historical aerial photographs, personnel interviews, operating information, investigation report summaries, and regulatory agency correspondence, inspection reports and memoranda/communication records, is discussed in detail in the Work Plan. A summary of the RI activities at the Site is provided below.

RI activities at the Site were initiated in 2006. These activities included the collection and analyses of soil, sediment, surface water, groundwater, and fish tissue samples. Results of these analyses were summarized in a Nature and Extent Data Report (NEDR) (PBW, 2009), which was approved by EPA on April 29, 2009. A summary of the NEDR findings relative to the areas addressed in this RAM is provided in Section 1.2.3 below.

A Final Baseline Human Health Risk Assessment (BHHRA) (PBW, 2010a) was prepared based on the data presented in the NEDR and was approved by EPA on March 5, 2010. A Final Screening-Level Ecological Risk Assessment (SLERA) (PBW, 2010b) was approved by EPA on June 9, 2010. Based on the SLERA conclusions, a Baseline Ecological Risk Assessment (BERA) was performed. Data collected for the BERA were presented in a Preliminary Site Characterization Report (PSCR) (URS, 2010b), which was approved by EPA on December 8, 2010. The BERA Report (URS, 2011) is currently in preparation.

A Time Critical Removal Action (TCRA) is currently being performed to remove residual material in the tanks at the AST Tank Farm. The Removal Action Report (PBW, 2011a) documenting the TCRA activities is currently in preparation.

1.2.3 Nature and Extent of Contamination

Key information pertaining to the former surface impoundments, and the nature and extent of chemicals of interest (COIs) in Site environmental media is summarized below. The nature and extent information data were previously provided in the NEDR (PBW, 2009a).

Former Surface Impoundments

The former surface impoundments consist of three earthen lagoons used for the storage of wash waters generated from barge cleaning operations. Covering an area of approximately 2.5 acres combined, the impoundments were reportedly three feet deep and contained a natural clay liner (TNRCC, 2000). The impoundments were closed in 1982 in accordance with a Texas Water Commission approved plan (Carden, 1982). Closure activities were reported to include: (1) removal of liquids and most of the impoundment sludges; (2) solidification of residual sludge that was difficult to excavate; (3) and capping with three-feet of clay and a hard-wearing surface (Guevara, 1989). As shown on a topographic survey of the area (Figure 4), the impoundments cap extends approximately 1.5 to 2.5 feet above surrounding grade. The cap crown slope is about 2% with slopes of 5 to 1 (horizontal to vertical) or less at the cap edge.

The construction materials, thickness, and condition of the former surface impoundments cap were evaluated through drilling and sampling of four borings through the cap, geotechnical testing of representative cap material (clay) samples, and performance of a field inspection of the cap, including observation of desiccation cracks, erosion features, and overall surface condition. As shown in Table 1, the surface impoundment cap thicknesses at the four boring locations ranged from 2.5 feet to greater than 3.5 feet. The geotechnical properties (Atterberg Limits, and Percent Passing # 200 Sieve) of the cap material as listed in Table 1 are consistent with those recommended for industrial landfill cover systems in TCEQ Technical Guideline No. 3 (TCEQ, 2009a) and the vertical hydraulic conductivities were all better (i.e., less) than the TCEQ guideline of 1×10^{-7} cm/sec.

The cap field inspection was performed on August 3, 2006. The cap appeared to be in generally good condition with no significant desiccation cracks or erosion features observed on the cap surface or slopes. The cap surface consisted of a partially vegetated crushed oyster shell surface overlying the clay layer. Some sporadic indications of animal (e.g., crab) penetrations of the cap surface were observed. Occasional debris (e.g., scrap wood and telephone poles) was observed on the surface and several large bushes (approximate height of three feet) were observed, mostly near the cap edges. Drilling rig and other heavy equipment (i.e. support truck) traffic across the western end of the cap in conjunction with Site investigation activities has resulted in surface rutting of the cap in this area.

Nature and Extent of COIs in Environmental Media

The nature and extent of COIs in Site environmental media was investigated in the RI through the installation and/or collection of 17 Site Intracoastal Waterway sediment samples, 9 background Intracoastal Waterway sediment samples, 4 Site Intracoastal Waterway surface water samples, 4 background Intracoastal Waterway surface water samples, 33 Site fish tissue samples, 36 background fish tissue samples, 190 South Area soil samples, 10 background soil samples, 41 off-site soil samples, 4 former surface impoundment cap soil borings, 29 North Area soil samples, 56 wetland sediment samples, 6 wetland surface water samples, 8 pond sediment samples, 6 pond surface water samples, 30 monitoring wells, 8 temporary piezometers, 5 permanent piezometers, and three soil borings. Most of these samples were analyzed for the list of COIs identified in the RI/FS Work Plan. Supplemental sampling of wetland sediments was performed in June 2010 and then additional samples were collected as part of BERA activities as described in Section 1.2.5 below. The nature and extent investigation locations (except for background sample locations) are plotted on Plate 1. The investigation conclusions as reported in the NEDR are summarized by area/media below. The extent of COIs in these media were determined through comparisons to extent evaluation comparison criteria identified in the RI/FS Work Plan as described in the NEDR.

- Intracoastal Waterway Sediments – Certain polynuclear aromatic hydrocarbons (PAHs) and 4,4’-DDT were the only COIs detected in Site Intracoastal Waterway sediment samples at concentrations exceeding extent evaluation comparison values. These exceedences were limited to sample locations within or on the perimeter of the barge slip areas. Based on these data, the lateral extent of contamination in Intracoastal Waterway sediments, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to several small localized areas within the two Site barge slips. A vertical extent evaluation does not apply to this medium.

- Intracoastal Waterway Surface Water – No COIs were detected at concentrations above their respective extent evaluation criteria in Intracoastal Waterway surface water samples collected adjacent to the Site.

- South Area Soils – COIs detected in South Area soils at concentrations exceeding extent evaluation criteria included certain metals, polychlorinated biphenyls (PCBs) and PAHs. The lateral extent of contamination in South Area soils, as defined by COI concentrations above their respective extent evaluation criteria, was identified as limited to the South Area of the Site and potentially a small localized area immediately adjacent to the Site on off-site Lot 20 immediately to the west of the Site. The vertical extent of COIs at concentrations above extent evaluation criteria in unsaturated South Area soils was identified as limited to depths less than four feet, as no exceedences were observed in any of the samples from this depth.

- North Area Soils – The only COIs detected in at least one North Area soil sample at concentrations exceeding their respective extent evaluation criteria were arsenic, iron, lead, 1,2,3-trichloropropane (1,2,3-TCP), trichloroethene (TCE), benzo(a)pyrene (BaP), dibenz(a,h)anthracene, and PCBs. The lateral extent of contamination in North Area soils, as defined by these few COI exceedences, was identified as limited to several small localized areas within this part of the Site where upland soils are present (i.e., within the area surrounded by wetlands). The vertical extent of COIs at concentrations above extent evaluation criteria in North Area soils extends to the saturated zone in some locations. Within the extent of North Area soil contamination, a small localized area of buried debris (rope, wood fragments, plastic, packing material, etc.) was encountered south of the former surface impoundments (locations NE3MW05, SB-204, SB-205, and SB-206 as shown on Plate 1). The projected extent of this buried debris area was estimated based on data from these locations and a June 1974 aerial photograph in which what appears to be the area is visible (Appendix C).

- Wetland Sediments – COIs detected in at least one wetland sediment sample at concentrations exceeding their respective extent evaluation criteria included certain metals, pesticides and PAHs. The lateral extent of contamination in wetland sediments, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to specific areas within the Site boundaries and small localized areas immediately north and east of the Site. The vertical extent of COIs at concentrations above extent evaluation criteria in wetland sediments was identified as limited to the upper one foot of unsaturated sediment.

- Wetland Surface Water – Acrolein, copper, mercury, and manganese were the only COIs detected in at least one wetland surface water sample at concentrations exceeding their respective extent evaluation comparison values. The lateral extent of contamination in wetland surface water, as defined by COIs concentrations above extent evaluation criteria, was identified as limited to localized areas within and immediately north of the Site. A vertical extent evaluation does not apply to this medium.

- Ponds Sediment – Zinc and 4,4'-DDT were the only COIs detected in at least one pond sediment sample at concentrations exceeding their respective extent evaluation comparison values. These exceedences were all limited to the "Small Pond" at the Site, which effectively defined the extent of contamination in pond sediments. A vertical extent evaluation does not apply to this medium.

- Ponds Surface Water – Arsenic, manganese, silver and thallium were the only COIs detected in at least one pond surface water sample at concentrations exceeding their respective extent evaluation comparison values. The lateral extent of pond surface water contamination, as defined by these exceedences, is limited to the extent of the two ponds. A vertical extent evaluation does not apply to this medium.

- Groundwater – The uppermost water-bearing unit at the Site, Zone A, is generally encountered at an average depth of approximately 10 feet bgs and has an average thickness of approximately 8 feet. Saturated conditions were encountered at depths as shallow as several feet in some borings near the former surface impoundments and in other areas of the Site. Although some semivolatile organic compounds (SVOCs) and metals were detected in Zone A groundwater at concentrations exceeding extent evaluation comparison values, VOCs, particularly chlorinated solvents, their degradation products, and benzene, were the predominant COIs detected in groundwater. The extent of VOCs exceeding extent evaluation comparison values was generally limited to a localized area within the North Area, roughly over the southern half of the former surface impoundments area and a similarly sized area immediately to the south (Figure 5). The next underlying water-bearing unit, Zone B, is generally encountered at an average depth of approximately 20 feet bgs and has an average thickness of approximately 7 feet. The lateral extent of contamination in this zone was limited to VOCs detected in a single well (NE3MW30B) located south of the former surface impoundments. The vertical extent of contamination in groundwater is limited to Zones A and B.

1.2.4 Contaminant Fate and Transport

Potential routes of migration for Site contaminants occur in the primary transport media of air, surface water/sediment (including runoff during storm events), and groundwater. Contaminant migration routes in these media are often interrelated. The physical and chemical characteristics of COIs and their potential transport media affect the degree of contaminant persistence and rate of migration within that media. A detailed contaminant fate and transport discussion will be provided in the RI Report (PBW, 2011b) currently in preparation. For the purposes of this RAM, key considerations from that discussion are highlighted below.

Potential Air Transport Pathways

Potential airborne contaminants at the Site consist predominantly of particles, as volatile COIs were generally not detected above screening levels in near surface (1 to 2 foot depth interval) soil samples (as specified in the Work Plan, surface soil samples were not analyzed for VOCs) and generally would not be expected to persist in surface soils. Thus potential contaminant transport via air is predominantly in the solid phase. In general, only fine-grained particles are susceptible to transport in air. COIs associated with the scrap metal present in surface fill soils in the South Area and some parts of the North Area would generally not be transported via the air pathway due to the size and density of these materials. Similarly, the predominantly vegetated and moist surface soils/sediments in the North Area are not generally conducive to dust generation and particle transport. The predominant wind direction in the region is from the southeast and south (TCEQ, 2009b). Thus, potential contaminant migration via the air transport pathway would generally be toward the north and northwest from Site Potential Source Areas (PSAs). Surface samples in the North Area generally downwind from the South Area PSAs most likely to contribute metals to surface particles, such as the sand blasting areas, did not indicate elevated concentrations of metals above extent evaluation levels, and thus airborne transport from these areas appears limited. Similarly lead concentrations in surface soil samples collected on Lots 19 and 20 directly west of the Site were relatively low and not indicative of significant air transport of contaminants from Site PSAs via entrainment and subsequent deposition of particles.

Potential Surface Water/Sediment Transport Pathways

The primary surface water/sediment pathways for potential contaminant migration from Site PSAs are: (1) erosion/overland flow to wetland areas north and east of the Site from the North Area due to rainfall runoff and storm/tide surge; and (2) erosion/overland flow to the Intracoastal Waterway from the South Area as a result of rainfall runoff and extreme storm surge/tidal flooding events. The low topographic slope of the Site and adjacent areas is not conducive to high runoff velocities or high sediment loads. Consequently, surface soil particles would not be readily transported in the solid phase. Additionally, the vegetative cover in the North Area serves to minimize soil erosion and resulting sediment load transport with surface water in these areas. Dissolved loads associated with surface runoff from the North Area would likewise be expected to be minimal due to the absence of exposed PSAs, generally low COI concentrations in North Area surface soils/sediments, and the relatively low solubilities of those COIs (primarily, pesticides, PAHs, and/or metals) that are present. Within the South Area, some PSAs, such as the sand blasting area, are exposed and COIs are present above extent evaluation levels at the ground surface. Exposed soils (primarily fill material) and indications of surface soil erosion are present within this area. Local areas of soil erosion and subsequent sediment deposition are apparent at the northern ends of the barge slips in Lots 21 and 22. The inference of surface soil erosion into the ends of the barge slips is supported by similar PAHs in sediment samples from the end of the barge slips and in nearby surface soil samples; however, the general absence of PAHs or other COIs in other areas of the barge slips toward the Intracoastal Waterway or within the waterway itself, suggests limited migration of COI-containing sediments.

Groundwater Transport Pathways

The groundwater pathway for potential transport of groundwater COIs is lateral migration within Zones A and B and vertical migration from Zone A to Zone B in areas where the clay separating Zone A and Zone B pinches out or is of minimal thickness. Vertical migration to deeper water-bearing zones below Zone B is effectively precluded by the thick (greater than 25 feet) and low vertical hydraulic conductivity (7×10^{-9} cm/sec) clay below Zone B.

Evaluations of the groundwater contaminant plume stability, the presence of potential contaminant biodegradation daughter products, and geochemical conditions favorable to biodegradation will be described in the RI report. These evaluations provide multiple lines of evidence for biodegradation of groundwater COIs and potential for limited future migration. The net overarching effect of fate and transport processes within the context of overall groundwater movement rates and directions can be assessed by considering the extent of observed contaminant migration relative to the timeframe over which that migration may have occurred. In the case of the Gulfco site, such an assessment is made through examination of the lateral extent of the primary groundwater COIs in Zone A relative to the operational period of the associated PSA, the former surface impoundments.

Barge cleaning operations at the Site began in 1971. The impoundments are visible in the 1974 aerial photograph in Appendix C. The impoundments were closed in 1982. Thus, contaminants introduced into the impoundments through barge wash waters and associated sludges have had the potential to migrate in groundwater for at least as long as 27 years (1982 to 2009) and potentially as long as 38 years (1971 to 2009). As shown on Figure 5, the lateral extent of contaminants in Zone A is generally limited to an area of approximately 200 ft or less (and in many cases, much less) from the boundary of the former surface impoundments. Dividing this distance by the potential migration period estimates of 27 to 38 years would correspond to contaminant migration rates of approximately 5 ft/year to 7 ft/year, which are consistent with both the low estimated velocity of groundwater in Zone A (discussed in the RI report) and further reductions in contaminant migration due to biodegradation. The limited extent of contaminant migration, low groundwater velocity and demonstrated contaminant degradation also predict limited potential for future migration, as is further supported by the general stability of the dissolved COI plumes.

1.2.5 <u>Risk Assessment</u>

Risk assessment provides a context for evaluating the significance of site contaminants, and is used to support risk management decisions for a site. Below are the summaries of the risk assessment activities for this Site. Human health and ecological receptors were considered in these evaluations under baseline conditions (i.e., prior to any remediation at the Site).

Human Health Risk Assessment

The Final BHHRA (PBW, 2010a) was submitted to EPA on March 31, 2010. The BHHRA used data collected during the RI to evaluate the completeness and potential significance of potential human health exposure pathways indentified in the Conceptual Site Model (CSM) first presented in the Work Plan. These pathways, as updated and presented in the BHHRA, are shown for the South Area in Figure 6 and for the North Area in Figure 7. The BHHRA evaluated the potential significance of the complete human health exposure pathways indicated in these figures and concluded that there were not unacceptable cancer risks or non-cancer hazard indices for any of the five current or future exposure scenarios except for future exposure to an indoor industrial worker if a building is constructed over impacted groundwater in the North Area.

Ecological Risk Assessment

The Final SLERA (PBW, 2010b) used data collected during the RI and was submitted to EPA on May 3, 2010. The SLERA concluded that it was necessary to proceed to the next phase of EPA's ecological risk assessment process by completing a BERA. The BERA addresses the potential for adverse ecological effects to the chemicals of potential ecological concern (COPECs) and receptors identified in the SLERA through a site-specific assessment. The necessity to move the ecological risk process into a site-specific BERA was based on exceedences of protective ecological benchmarks for direct contact toxicity to invertebrates in the sediment in the wetlands and Intracoastal Waterway, soil in the North Area, and surface water in the wetlands as described in the SLERA. No literature-based food chain hazard quotients (HQs) exceeded unity (1) in the SLERA and, as such, adverse risks to higher trophic level receptors are unlikely and were not evaluated further through the BERA process.

Based on the SLERA conclusions and per the study outlined in the BERA Work Plan & Sampling and Analysis Plan (BERA WP/SAP) (URS, 2010a), the BERA included analytical chemistry analysis and toxicity testing of soil, sediment, and surface water samples corresponding to a gradient of COPEC concentrations. Figures 8 and 9 show the relevant pathways and receptors of potential concern that were evaluated in the BERA. The BERA data, as presented in the PSCR (URS, 2010b), indicate the following:

- The testing of *Neanthes arenaceodentata* showed no statistically significant differences between the North Area soil samples and the reference samples.
- Toxicity testing of wetland sediment using *Neanthes arenaceodentata* and *Leptocheirus plumulosus* showed no statistically significant differences between the Site wetland sediment samples and the reference wetland samples for either the growth or mortality endpoints.
- The toxicity testing of wetland surface water using *Artemia salina* showed no consistent mortality trends.
- Toxicity testing of Intracoastal Waterway sediment using *Neanthes arenaceodentata* and *Leptocheirus plumulosus* showed no statistically significant differences between the Site Intracoastal Waterway sediment samples and the Intracoastal Waterway reference samples for either the growth or mortality endpoints.
- There were no observable trends between concentration, benchmark exceedences, and observed toxicity.

These data suggest that adverse ecological risks from direct exposure to invertebrates in the soils, sediments and surface water are unlikely. Accordingly and consistent with discussions with EPA and TCEQ representatives in the BERA data review and planning meeting on December 1, 2010, ecological-based PRGs were not developed for this Site.

The BERA Report (URS, 2011) documenting the above conclusions is currently in preparation.

2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLGIES

2.1 INTRODUCTION

As described in EPA guidance (EPA, 1988) the remedial alternatives development and screening process consists of the following six general steps:

- Development of remedial action objectives;
- Development of general response actions;
- Identification of volumes or areas to which the general response actions might be applied;
- Identification and screening of technologies applicable to each general response action;
- Identification and evaluation of technology process options to select a representative process for each technology type; and
- Assembly of representative technologies into alternatives.

Consistent with the goal of organizing this RAM to correspond to the suggested format for the technology and alternative screening sections of the FS, Sections 2.2 through 2.4 below describe how the first five steps of this process are used to select remedial technologies for consideration at the Site. The assembly of these technologies into remedial alternatives in the sixth step is described in Section 3.1.

2.2 REMEDIAL ACTION OBJECTIVES

RAOs consist of medium-specific goals for protecting human health and the environment. As such, RAOs are developed for those exposure pathways identified as posing an unacceptable risk to either: (1) human receptors as described in the BHHRA; and/or (2) ecological receptors based on data developed in the BERA. As noted previously, the BERA (URS, 2011) is currently in preparation and has not been reviewed by EPA. Based on data presented in the approved PSCR and discussions with EPA and TCEQ representatives on December 1, 2010, it is anticipated that the RAOs for this Site will not be based on ecological endpoints given the lack of potential risk to these receptors. RAOs were identified for two areas/media at the Site based on concerns related to future human health exposure: (1) the Former Surface Impoundments; and (2) North Area groundwater. The RAOs for these areas are described below.

2.2.1 Former Surface Impoundments

As noted previously, the former surface impoundments contain residual barge cleaning wash water sludge that was reportedly solidified when the impoundments were closed by capping in 1982 in accordance with the Texas Water Commission approved plan (Carden, 1982). This residual sludge, along with wash waters stored in the impoundments prior to closure, is believed to be the source of the VOCs and other chemicals detected in North Area groundwater in the impoundments vicinity. The cap inspection described previously documented the cap to be in generally good condition with no significant desiccation cracks or erosion features and generally acceptable side slopes, although some penetrations, surface debris, large bushes and surface rutting were observed. An inspection after Hurricane Ike did not indicate significant damage. In addition, a localized area of buried debris was identified immediately south of the former surface impoundments. Based on this information, the RAOs for this area are: (1) to reduce the potential for waste (i.e., residual sludge and/or buried debris) exposure, through future surface erosion and/or cap penetration; and (2) to reduce the potential for increased contaminant loading from waste to groundwater through cap failure.

Numeric PRGs have not been calculated to support this RAO because the risk issue of concern identified for the former surface impoundments is not quantifiable. Potential future exposure to buried debris and waste in the former surface impoundments is highly uncertain and may not occur, therefore, numeric PRGs are not appropriate.

2.2.2 Groundwater

The NEDR and BHHRA note that groundwater in affected water-bearing units at the Site (Zones A and B) and the next underlying water-bearing unit (Zone C) is not useable as a drinking water source due to naturally high total dissolved solids (TDS) concentrations. Consequently, the only potentially unacceptable human health risks associated with COIs detected in Site groundwater are for the pathway involving volatilization of VOCs from North Area groundwater to a hypothetical indoor air receptor. This conclusion is based on the continued stability of the current COI plume, both in terms of lateral extent in Zones A and B and the absence of COIs in deeper water-bearing units. Restrictive covenants currently in place for Lots 55 through 57 (shown on Figure 2), which encompass the area of the VOC plume (as shown on Figure 5), require EPA and TCEQ notification and approval prior to construction of any buildings on these parcels. The covenants (included as Appendix B to this memorandum) also advise that response actions, such as protection against indoor vapor intrusion, may be necessary prior to building construction. Thus, the RAOs for contaminated groundwater are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent and absence of impacts above screening levels to underlying water bearing units; and (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway.

As described in the SLERA (PBW, 2010b), there are no complete exposure pathways for ecological receptors to contact COIs in groundwater and, as such, this RAO was developed to be protective of potential future exposure to human receptors. Numeric PRGs were not calculated for this pathway since the deed restrictions will effectively prevent future exposure.

2.3 GENERAL RESPONSE ACTIONS

While RAOs are generally focused on specific potential exposure pathways, media and/or contaminant levels, general response actions describe the types of actions to be taken to satisfy the identified RAOs. As described in EPA guidance (EPA, 1988), general response actions may include treatment, containment, excavation, extraction, disposal, institutional controls, or a combination of those. General response actions, along with preliminary estimates of the area/volumes to be addressed by those response actions (as applicable) are described below for each of the two areas/media for which RAOs were identified in Section 2.2. For the purposes of this RAM, the “no action” response action is not included in the discussions below; however, consistent with EPA guidance (EPA, 1988), the “no action” alternative will be evaluated in the FS.

2.3.1 Former Surface Impoundments

The RAOs for the former surface impoundments area are: (1) to reduce the potential for waste exposure through future surface erosion and/or cap penetration; and (2) to reduce the potential for increased contaminant loading from waste to groundwater through cap failure. The general response actions to address these RAOs for the former surface impoundment residual wastes are:

- Containment;
- On-site Treatment; and
- Excavation/Off-site Management.

A containment-based response action would entail either repair/upgrade or replacement of the existing former surface impoundment cap and extension of the upgraded cap over the buried debris area. An on-site treatment-based response action would include cap removal followed by either: (1) in-situ treatment through physical, biological, or chemical means; or (2) waste/debris excavation and treatment followed by on-site disposal of the treated material. An off-site management-based response action would involve excavation of the former surface impoundment sludge material and buried debris followed by shipment to an off-site facility for treatment, and/or disposal.

The former surface impoundments share many similarities with municipal landfill sites addressed under CERCLA. As described in EPA's *Feasibility Study Analysis for CERCLA Municipal Landfill Sites* (EPA, 1994b), municipal landfill (MLF) sites on the NPL are characterized by large volumes of heterogeneous waste, frequently including municipal waste co-disposed with industrial and/or hazardous waste. The volume and characteristics of wastes at these sites along with the disposal history is variable and often uncertain, with typical COIs including a variety of VOCs, SVOCs, and potentially inorganic compounds and metals (EPA, 1994b). The former surface impoundments at the Gulfco site contain an undetermined volume of waste, consisting of a heterogeneous mixture of residual industrial sludge from former barge cleaning operations and soils reportedly added to stabilize the sludge at the time of closure. Similarly, the specific volume of buried debris observed immediately south of the former surface impoundments has not been determined.

EPA has established containment as the presumptive remedy for CERCLA MLFs (EPA, 1993). This designation was based on a review of remedial alternatives analyses performed at multiple MLFs (EPA, 1991) and is consistent with EPA expectations that containment technologies will generally be appropriate for waste that poses relatively low long-term threat or where treatment is impracticable (EPA, 1994b). As defined in the presumptive remedy guidance (EPA, 1993), containment relates primarily to containment of the landfill mass and/or treatment of landfill gas (produced by the decay of putrescible material in municipal waste within the landfill). Containment may also include leachate or groundwater control at the landfill perimeter, and/or institutional controls, as necessary. Potential long-term groundwater response actions, if any, at MLFs are beyond the scope of the presumptive remedy. One of the purposes of a presumptive remedy is to facilitate a streamlined evaluation of remedial alternatives during the FS. In effect, the establishment of containment as a presumptive remedy fulfills the FS requirements for screening of potential remedial technologies and assembly of remedial alternatives, and allows the remedial alternatives evaluation to proceed directly to the screening of remedial alternatives.

Given the similarities of the former surface impoundments to CERCLA MLFs, the technology screening performed at multiple MLF sites to support containment as a presumptive remedy (EPA, 1994b) can effectively serve as the technology screening for the former surface impoundments at the Gulfco site. As such, Section 2.4 of this RAM includes a discussion of the technology identification and screening process for containment-based alternatives only. Similarly, Section 3.0 assembles and evaluates only containment-based alternatives. Since putrescible wastes were not reported within the former surface impoundments and were generally not observed in the debris area, production of landfill gas is not a likely concern and thus landfill gas management has not been included as a component of the containment-based remedial alternatives considered in Section 3.0. In the same way, given the nature of the waste material within the former surface impoundments and the buried debris area, the shallow water table at the Site, and the demonstrated extent and stability of the associated VOC groundwater plume, leachate collection and perimeter groundwater control are not included in the containment alternatives discussed for this area in Section 3.0.

The former surface impoundments and the buried debris area cover a projected area of approximately 3 acres, as shown on Figure 4. This acreage encompasses the entire area within the existing cap and the projected boundary of the buried debris area as estimated from the aerial photograph in Appendix C.

2.3.2 Groundwater

The RAOs for groundwater are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent, and the absence of impacts above screening levels to underlying water-bearing units; and (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway. The general response actions to address these RAOs for groundwater are:

- Monitoring/Institutional Controls;
- Containment; and
- In-situ Treatment.

A monitoring/institutional controls response action would include ongoing groundwater monitoring to demonstrate continued plume stability and review/evaluation of the current restrictive covenant requiring EPA and TCEQ notification and approval prior to construction of buildings and advising protection against indoor vapor intrusion as part of any building construction. A containment response action could entail either construction of a physical barrier, such as a slurry wall to contain affected groundwater or a groundwater collection and treatment system to provide hydraulic containment. An in-situ treatment response action would involve injection of reagents to facilitate biological or chemical treatment of the VOCs such that concentrations were reduced to levels protective of the potential groundwater to indoor air pathway and potential future migration. The identification and screening of potential technologies for these general response actions is performed in Section 2.4.2. The general extent of groundwater contamination as indicated by VOC concentrations in Zone A exceeding their respective extent evaluation comparison values is shown on Figure 5. VOC isoconcentration maps providing the basis of the extent area shown in this figure are provided in the NEDR. Additional explanation of these data will be provided in the RI Report (PBW, 2011b).

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Prior to developing remedial alternatives for the general response actions described in Section 2.3, it is necessary to identify potentially applicable remedial technologies for each area/medium and screen the technologies to select only those processes that would be potentially effective at meeting the RAOs and are implementable. In the sections below, potentially applicable remedial technologies and process options are identified for the general response actions and are screened in accordance with procedures in EPA guidance (EPA, 1988). The following screening criteria were applied to each technology/process option to determine if the technology was applicable to the specific general response action being considered, and thus worthy of more detailed analysis:

- Effectiveness
    - Potential effectiveness in meeting RAOs

  - Potential impacts to human health and the environment
  - Reliability/applicability to Site COIs and conditions

- Implementability
  - Technical/administrative feasibility of implementing the technology

- Cost
  - Capital/Operation and Maintenance (O&M) costs relative to other technologies (i.e., low, moderate, high, etc.)

2.4.1 Former Surface Impoundments

The general response actions for the former surface impoundments are:

- Containment;
- On-site Treatment; and
- Excavation/off-site management.

As described in Section 2.3.1, the former surface impoundments are similar to CERCLA MLFs for which EPA has identified containment as a presumptive remedy. As such, the technology screening presented in Table 2 for this area focuses on containment and related technologies. Institutional and access controls are evaluated in Table 2 as supporting technologies for a containment-based response action and not as a stand-alone technology. Consistent with the former surface impoundments RAOs of: (1) reducing the potential for waste (i.e., residual sludge and/or buried debris) exposure, through future surface erosion and/or cap penetration; and (2) reducing the potential for increased contaminant loading from waste to groundwater, through cap failure, three capping technologies were evaluated in Table 2. Of these, repair and upgrade of the existing cap was retained for use in developing potential remedial alternatives based on a higher effectiveness, higher implementability, and lower capital cost as described in Table 2.

2.4.3 Groundwater

The general response actions for groundwater are:

- Monitoring/Institutional Controls;
- Containment; and
- In-situ Treatment.

Table 3 presents the technologies considered for these general response actions and summarizes the screening process by which these technologies were evaluated. Two monitoring/institutional control technologies (restrictive covenants and groundwater monitoring) were included in this evaluation. Both of these were retained for further evaluation and use in developing remedial alternatives.

Four physical containment technologies were screened in Table 3. These included two slurry wall technologies, sheet piling, and permeable reaction walls (designed to let groundwater pass but contain contaminants). Due to very high costs and concerns over potential adverse impacts to large areas of Site wetlands during construction, none of these technologies were retained for further evaluation.

Containment by hydraulic control was considered through the screening of four technologies, groundwater extraction via vertical wells and three subsurface drain technologies (conventional interceptor trenches, single pass trenching drains, and horizontal wells). Due to high costs, and/or low implementability for the subsurface drain technologies, the vertical extraction well option was retained as the hydraulic control technology for further evaluation and use in developing remedial alternatives.

Twelve treatment technologies, including two biological process options, nine physical/chemical process options, and one thermal process option, were considered for management of collected groundwater. As noted in Table 3, many of these technologies were characterized by low effectiveness, relatively lower implementability, and/or moderate to high costs. As a result of this screening, low profile aeration was retained as the aqueous phase treatment technology for further evaluation and use in developing remedial alternatives. Similarly, catalytic oxidation was retained as the vapor phase treatment technology for further evaluation and use in developing remedial alternatives.

Three post-treatment discharge options were considered: on-site discharge through injection wells, off-site discharge to the City of Freeport Publically Owned Treatment Works (POTW), and direct discharge to the Intracoastal Waterway. As detailed in Table 3, the POTW discharge was the surviving option from this screening, due to less stringent treatment requirements (and thus lower treatment costs) and lesser potential implications from any treatment system upsets.

In-situ treatment technologies were evaluated through biological and chemical treatment options. Due to the low effectiveness and low implementability of these technologies at the Site, neither was retained for further evaluation.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Consistent with the remedial alternatives development and screening process described in EPA guidance (EPA, 1988) and summarized previously in Section 2.1 of this RAM, the sixth (and final step) of the process is the assembly of representative technologies retained from the screening evaluation into remedial alternatives. This step is described in Section 3.1, below, for each of the two affected media/areas for which RAOs were identified. Section 3.2 provides a screening evaluation of these alternatives for effectiveness, implementability, and cost as recommended in EPA guidance (EPA, 1988). A detailed analysis of these alternatives against the nine CERCLA evaluation criteria will be performed in the FS to be prepared upon approval of this RAM.

3.1 DEVELOPMENT OF ALTERNATIVES

Table 4 illustrates how surviving technology options for the former surface impoundments, and affected groundwater were combined into three Site-wide remedial alternatives. Brief descriptions of each of these alternatives are provided below:

- <u>Alternative 1 – No Action.</u> Consideration of a no action alternative is specified in EPA guidance (EPA, 1988). This alternative serves as a baseline against which other alternatives are evaluated. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative effectively represents the baseline conditions evaluated in the BERA and BHHRA.

- <u>Alternative 2 – Former Surface Impoundments Containment and Groundwater Controls/Monitoring.</u> This alternative uses containment and institutional control technologies to address RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface; (2) deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap; (3) fencing (three-strand barbed wire) of the capped area; (4) review/evaluation of the current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; and (5) annual groundwater monitoring to confirm continued stability of the affected groundwater plume. It should be noted that the current restrictive covenants described in Item 4 above are included in Appendix B herein.

- Alternative 3 – Impoundment and Groundwater Containment. This alternative uses containment technologies to addresses RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface; (2) deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap; (3) fencing (three-strand barbed wire) of the capped area; (4) review/evaluation of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; (5) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (6) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (7) discharge of treated groundwater to the City of Freeport POTW; and (8) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

3.2 SCREENING OF ALTERNATIVES

3.2.1 Introduction

As described in EPA guidance (EPA, 1988), remedial alternatives are developed to meet the identified RAOs for each area/medium of interest. During screening, the assembled alternatives are evaluated to ensure that they protect human health and the environment from each potential pathway of concern at the Site. Thus for the alternative screening, the assembled alternatives are evaluated against short-term and long-term aspects of effectiveness, implementability, and cost. These criteria are defined in the EPA guidance (EPA, 1988) for alternatives screening as follows:

- Effectiveness - This criterion pertains to the effectiveness of each alternative in protecting human health and the environment and the reductions in toxicity, mobility and volume that it will achieve. Short-term effectiveness is evaluated relative to the alternative construction and implementation period. Long-term effectiveness is evaluated relative to the period after the remedial action is complete. Reduction of toxicity, mobility, or volume refers to changes in contaminant or contaminated media characteristics by the use of treatment that decreases inherent risks or threats.

- Implementability – This criterion pertains to the technical and administrative feasibility of constructing, operating, and maintaining each alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific requirements until a remedial action is complete. It also includes the operation, maintenance, replacement, and monitoring, or technical components of alternatives into the future after the remedial action is complete (as applicable). Administrative feasibility includes both the ability to obtain any necessary approvals from regulatory agencies and the availability of treatment, storage, and disposal services and capacity.

- Cost – Both capital and O&M costs are considered for this criterion. Cost evaluation is performed on a present worth basis to evaluate expenditures that occur over different time periods.

3.2.2 Alternative 1 – No Action

The no action alternative is not effective at providing additional protection of human health and the environment with regard to the identified RAOs in either the short- or long-term. Similarly, this alternative achieves no reductions in toxicity, mobility and volume. Since the alternative entails no action, it is readily implemented and has no associated capital or operation and maintenance (O&M) costs. CERCLA requires evaluation of a no action alternative, so Alternative 1 is retained for detailed analysis in the FS.

3.2.3 Alternative 2 – Impoundment Containment and Groundwater Controls/Monitoring

Alternative 2 addresses the former surface impoundments RAOs of reducing the potential for waste exposure and reducing the potential for increased contaminant loading from the impoundment wastes to groundwater by upgrading the existing cap and implementing institutional controls and fencing to protect the cap. These remedy components are effective in protecting human health and the environment during the short-term as no wastes would be exposed during construction, and they also provide long-term protection for the RAOs. No reductions in toxicity, mobility and volume of the impoundment wastes through treatment are achieved by this alternative.

The groundwater RAOs of verifying continued VOC plume stability and maintaining protection against potential VOC exposures via the groundwater to indoor air pathway are addressed by the groundwater monitoring program and by the current restrictive covenants described previously. These alternative components are effective in protecting human health and the environment in accordance with the groundwater RAOs. No reductions in toxicity, mobility and volume of groundwater contamination through added treatment are achieved by this alternative; however, it should be noted that the natural attenuation processes occurring in Site groundwater provide natural biological treatment that would, over time, be expected to provide a reduction in toxicity, mobility, and/or volume.

All components of Alternative 2 are readily implemented. Cap upgrades, fencing, institutional controls and monitoring programs are all commonly used technologies that are very feasible from both technical and administrative perspectives.

A preliminary cost evaluation of Alternative 2 for the purposes of this alternative screening is provided in Table 5. Key assumptions regarding cap upgrade material volumes, fencing lengths, and monitoring program requirements are listed in this table. The preliminary total present worth cost, including contingencies for this alternative is projected at $ 700,000.

This preliminary screening determined that Alternative 2 is effective, implementable and of estimable cost. Thus Alternative 2 is retained for a more detailed analysis in the FS.

3.2.4 Alternative 3 – Impoundment and Groundwater Containment

Alternative 3 addresses the former surface impoundments RAOs of reducing the potential for waste/debris exposure and reducing the potential for increased contaminant loading from the impoundment wastes to groundwater by upgrading the existing cap, and implementing institutional controls and fencing to protect the cap. These remedy components are effective in protecting human health and the environment during the short-term as no wastes would be exposed during construction, and they also provide long-term protection for the RAOs. No reductions in toxicity, mobility and volume of the impoundment wastes through treatment are achieved by this alternative.

The groundwater RAOs of verifying continued VOC plume stability and maintaining protection against potential VOC exposures via the groundwater to indoor air pathway are addressed through hydraulic control of groundwater and by the restrictive covenants described previously. Hydraulic control of groundwater is maintained by groundwater extraction, treatment by air stripping and discharge to the City of Freeport POTW. These alternative components are effective in protecting human health and the environment in accordance with the groundwater RAOs. Although some reductions in toxicity, mobility and volume of groundwater contamination through treatment are achieved by this alternative, the groundwater objective is containment and thus toxicity, mobility and volume reductions to levels obviating the need for ongoing containment are not expected. The natural attenuation processes occurring in Site groundwater that provide natural biological treatment mentioned previously may also over time provide reductions in toxicity, mobility, and/or volume.

All components of Alternative 3 are readily implemented. Off-site waste disposal, cap upgrades, fencing, institutional controls and groundwater extraction and treatment are all commonly used technologies that are very feasible from both technical and administrative perspectives. Adequate off-site waste management capacity is available through multiple commercial facilities. Although not confirmed, it is reasonable to expect adequate sanitary sewer line and treatment capacity is available at the City of Freeport POTW. In-depth discussions with the City regarding capacity, pre-treatment requirements, etc. would be needed prior to further consideration of this alternative.

A preliminary cost evaluation of Alternative 3 for the purposes of this alternative screening is provided in Table 6. Key assumptions regarding cap upgrade material volumes, fencing lengths, groundwater extraction/treatment rates, and monitoring program requirements are listed in this table. The preliminary total present worth cost, including contingencies for this alternative is projected at $ 3,500,000.

This preliminary screening determined that Alternative 3 is effective, implementable and of estimable cost. Thus Alternative 3 is retained for a more detailed analysis in the FS.

4.0 CONCLUSIONS

The purpose of the RAM is to develop a range of remedial alternatives and screen those alternatives in relation to the RAOs in order to allow a more detailed analysis of alternatives in the FS. RAOs were identified for two areas/media at the Site based on concerns related to future human health exposure: (1) the Former Surface Impoundments; and (2) North Area groundwater. The RAOs for the former surface impoundments area are: (1) to reduce the potential for waste exposure through future surface erosion and/or cap penetration; and (2) to reduce the potential for increased contaminant loading from waste to groundwater through cap failure. The RAOs for groundwater are: (1) to verify, on an ongoing basis, the continued stability of the VOC plume in Zones A and B, both in terms of lateral extent, and the absence of impacts above screening levels to underlying water-bearing units; and (2) to maintain, as necessary, protection against potential exposures to VOCs at levels posing an unacceptable risk via the groundwater to indoor air pathway.

General response actions were identified to address the above RAOs. Remedial technologies potentially applicable to those general response actions were screened and the surviving technologies were then assembled into remedial alternatives. Based on this process the following remedial alternatives were developed:

- Alternative 1 – No Action. Under this alternative, no remedial action or institutional controls (beyond those currently in place) are implemented. This alternative serves as a baseline against which other alternatives are evaluated.

- Alternative 2 – Former Surface Impoundments Containment and Groundwater Controls/Monitoring. This alternative uses containment and institutional control technologies to addresses RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface; (2) deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap; (3) fencing (three-strand barbed wire) of the capped area; (4) review/evaluation of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; and (5) annual groundwater monitoring to confirm continued stability of the affected groundwater plume.

- Alternative 3 – Impoundment and Groundwater Containment. This alternative uses containment technologies to addresses RAOs for the former surface impoundments, and affected groundwater. It includes the following: (1) upgrade/repair of the existing cap at the former surface impoundments through surface debris and brush removal from the cap, grading/compaction of the existing clay cap, placement of an additional clay layer over the existing cap, extension of the existing cap over the nearby buried debris area, placement of a topsoil layer over the clay cap, and vegetation of the cap surface; (2) deed recordation of the former surface impoundment and buried debris area, including filing of a restrictive covenant prohibiting disturbance of the cap; (3) fencing (three-strand barbed wire) of the capped area; (4) review/evaluation of current restrictive covenants prohibiting groundwater use on Lots 55 through 57 of the Site and requiring protection against indoor vapor intrusion for building construction on these lots; (5) installation/operation of a series of vertical groundwater extraction wells to provide hydraulic control of affected groundwater; (6) treatment of collected groundwater using low profile aeration with off-gas treatment by catalytic oxidation; (7) discharge of treated groundwater to the City of Freeport POTW; and (8) annual groundwater monitoring to verify the effectiveness of groundwater hydraulic control.

These three alternatives were screened against the initial criteria of short-term and long-term aspects of effectiveness, implementability, and cost. As a result of that process, all three were retained for a detailed analysis relative to the full suite of nine CERCLA evaluation criteria in the FS.

5.0 REFERENCES

Carden, Clair A., 1982. Fish Marine Services, Freeport, Texas, Pond Closure Certification. August 18.

City of Freeport (Freeport), 2009. Code of Ordinances. American Legal Publishing. http://www.amlegal.com/nxt/gateway.dll/Texas/freeport_tx/cityoffreeporttexascodeofordinances?f=templates$fn=default.htm$3.0$vid=amlegal:freeport_tx. Accessed June 25, 2009.

Fish Engineering & Construction, Inc. (Fish), 1981. Letter from G.J. Gill to Texas Department of Water Resources (TDWR). November 17.

Guevara, Jairo, 1989, Record of Communication for Reconnaissance Inspection of Former Surface Impoundments of Fish Engineering & Construction, Inc. November 28.

Pastor, Behling & Wheeler, LLC (PBW), 2006. Final RI/FS Work Plan, Gulfco Marine Maintenance Site, Freeport, Texas. May 16.

Pastor, Behling & Wheeler, LLC (PBW), 2009. Final Nature and Extent Data Report, Gulfco Marine Maintenance Site, Freeport, Texas. May 20, 2009.

Pastor, Behling & Wheeler, LLC (PBW), 2010a. Final Baseline Human Health Risk Assessment, Gulfco Marine Maintenance Site, Freeport, Texas. March 31.

Pastor, Behling & Wheeler, LLC (PBW), 2010b. Final Screening-Level Ecological Risk Assessment Report, Gulfco Marine Maintenance Site, Freeport, Texas. May 3.

Pastor, Behling & Wheeler, LLC (PBW), 2011a. Tank Removal Action Report, Gulfco Marine Maintenance Site, Freeport, Texas. In preparation.

Pastor, Behling & Wheeler, LLC (PBW), 2011b. Remedial Investigation Report, Gulfco Marine Maintenance Site, Freeport, Texas. In preparation.

Texas Commission on Environmental Quality (TCEQ), 2009a. Technical Guideline No. 3 – Landfills. Revised June 12.

Texas Commission on Environmental Quality (TCEQ), 2009b. Houston Intercontinental Airport Wind Rose. http://www.tceq.state.tx.us/assets/public/compliance/monops/air/windroses/iahall.gif. Accessed July 3, 2009.

Texas Department of Water Resources, 1982a. Letter to Mr. C. J. Gill, Fish Engineering and Construction, Inc. February 26.

Texas Department of Water Resources, 1982b. Letter to Mr. C. J. Gill, Fish Engineering and Construction, Inc. May 21.

Texas Natural Resource Conservation Commission (TNRCC), 2000. Screening Site Inspection Report, Gulfco Marine Maintenance, Inc. Freeport, Brazoria County, Texas TXD 055 144 539. Prepared in cooperation with the U.S. Environmental Protection Agency. July.

Texas Water Commission (TWC), 1985. Technical Guideline No. 1 - Waste Evaluation/Classification. Revised December 6.

United States Environment Protection Agency (EPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (Interim Final). OSWER Directive 9355.3-01. EPA/540/G-89/004. October.

United States Environment Protection Agency (EPA), 1989a. Determining When Land Disposal Restrictions (LDRs) Are Applicable to CERCLA Response Actions. Superfund LDR Guide #5. OSWER Directive 9347.03-05FS. July.

United States Environment Protection Agency (EPA), 1989b. RCRA ARARs: Focus on Closure Requirements. OSWER Directive 9234.0-04FS. October.

United States Environment Protection Agency (EPA), 1991. Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites. OSWER Directive 9355.3-11. EPA/540/P-91/001. February.

United States Environment Protection Agency (EPA), 1993. Presumptive Remedy for CERCLA Municipal Landfill Sites. OSWER Directive 9355.0-49FS. EPA/540/F-93/035. September.

United States Environment Protection Agency (EPA), 1994a. Considering Wetlands at CERCLA Sites. OSWER Publication 9280.0-03. EPA/540/R-94/019. May.

United States Environment Protection Agency (EPA), 1994b. Feasibility Study Analysis for CERCLA Municipal Landfill Sites. OSWER Directive 9356.0-03. EPA/540/R-94/081. August.

United States Environment Protection Agency (EPA), 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. OSWER Directive 9355.0-75. EPA/540/R-00/002. July.

United States Fish and Wildlife Service (USFWS), 2008. National Wetlands Inventory, Online Wetlands Mapper. http://wetlandsfws.er.usgs.gov/wtlnds/launch.html. Accessed July 9, 2008.

URS Corporation (URS), 2010a, Final Baseline Ecological Risk Assessment Work Plan & Sampling and Analysis Plan, Gulfco Marine Maintenance Site, Freeport, Texas. September 2.

URS Corporation (URS), 2010b, Final Preliminary Site Characterization Report, Gulfco Marine Maintenance Site, Freeport, Texas. November 30.

URS Corporation (URS), 2011, Baseline Ecological Risk Assessment Report, Gulfco Marine Maintenance Site, Freeport, Texas. In preparation.

TABLES

FIGURES

PLATE

APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) EVALUATION

APPENDIX B

RESTRICTIVE COVENANTS

APPENDIX C

JUNE 28, 1974 AERIAL PHOTOGRAPH